North Coast Watershed Assessment Program

DRAFT

Redwood Creek Watershed Synthesis Report

The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.

Public Review Draft

Redwood Creek Watershed Profile

Introduction

Redwood Creek covers 282 square miles (180,000 acres) of mostly forested upland. The basin is 65 miles long with the headwaters located near Board Camp Mountain, in Northern Humboldt County. The watershed drains into the Pacific Ocean near the town of Orick. Elevation within the basin ranges from sea level at the town of Orick up to 5,200 feet at Board Camp Mountain. The Redwood Creek watershed is situated in a tectonically active and geologically complex area, with some of the highest rates of uplift, and seismic activity in North America (Cashman et al, 1995, Merritts, 1996). Most of the bedrock underlying the watershed has been broken and sheared by tectonic action making it relatively weak, easily weathered, and naturally susceptible to landsliding and erosion. Heavy rainfall, high regional uplift rates and seismicity combined with weak bedrock and erodible soil conditions produce widespread landsliding and high sediment input to streams.

Vegetation varies from old growth redwood forest along the lower portion of the drainage to Douglas-fir, intermixed with oak woodlands and hardwoods to ponderosa and Jeffery pine stands along the upper elevations. Areas of grasslands are also found along the main ridge tops and south facing slopes of the watershed. Prior to the harvesting of timber within the Redwood Creek watershed, 83 percent of the drainage supported mature coniferous forests. The remainder of the watershed, approximately 17 percent supports grasslands and oak woodlands. Redwood Creek drainage currently supports about 24,000 acres of old-growth coniferous forests. Approximately 68 percent of the total watershed area has been logged at least once.Redwood Creek basin supports populations of fall run chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (O. kisutch), winter and summer runs of steelhead trout (O. mykiss), coast cutthroat trout (O. clarki clarki), and other valuable fisheries resources. The salmon, cutthoat, and steelhead are traditionally important as food and recreation to local residents and visitors to the Redwood Creek area and the presence of a healthy fishery provides an important source of revenues to the local economy.

Subbasin Scale

Natural variation in subbasins is at least partially a product of natural and human disturbances. Other variables that can distinguish areas, or subbasins, in larger basins include differences in elevation, geology, soil types, aspect orientation, climate, vegetation, fauna, human population, land use and other social-economic considerations. The combined complexity of large basins makes it difficult to speak about them concerning watershed assessment and recommendation issues in other than very general terms. In order to be more specific and useful to planners, managers, and landowners, it is useful to subdivide the larger basin units into smaller subbasin units whose size is determined by the commonality of many of the distinguishing traits.

Climate

Annual precipitation ranges in amount from 32 to 98 inches and falls mostly during the winter and spring. Average rainfall is approximately 70 to 80 inches per year, with frequent snow above 1600 feet during winter months. Temperatures vary only slightly along the coast, inland areas experience a greater fluctuation. Mean temperatures at Redwood Park are 47 in January and 59 in June. Fog is a dominant climatic feature along the coast, generally occurring daily in the summer and not infrequently throughout the year. Higher elevations and inland areas tend to be relatively fog free.

Hydrology

Diversions, Dams, and Power Generation

Material prepared by the Department of Water Resources was not ready in time to include in the main text. See their appendix for the detailed information that will be incorporated here later.

Geology

Most of the bedrock underlying the watershed has been broken and sheared by tectonic action making it relatively weak, easily weathered, and naturally susceptible to landsliding and erosion. Heavy rainfall, high regional uplift rates and seismicity combined with weak bedrock and erodible soil conditions produce widespread landsliding and high sediment input to streams. The character of the local sediment load (coarse versus fine-grained) can be affected or controlled by the bedrock and/or type of landslide present in the vicinity.

The following section provides a brief description of the watershed geology and related landslide processes. More detailed discussions of the geology underlying the watershed, the associated mass wasting processes and land use issues are provided in the Geology Report (see Appendices) along with 1:24,000 scale maps showing the distribution of the geologic units and mass wasting features.

The Redwood Creek watershed is situated in a tectonically active and geologically complex area, with some of the highest rates of uplift, and seismic activity in North America (Cashman et al, 1995, Merritts, 1996). Bedrock units associated with the Central Belt of the Franciscan Complex largely underlie the watershed. Older rocks associated with the Klamath Terrane underlie a small portion of the southeastern boundary of the watershed (see Figure XX, Tectonic Setting of Northern California and Geologic Map of the Redwood Creek Watershed) The Franciscan Complex rocks are predominantly tectonically deformed and altered marine sedimentary rocks (Harden and others, 1982).

The bedrock units are separated by a series of northwest-trending faults. The Grogan Fault dominates the drainage and appears to control the orientation of the Redwood Creek channel for much of its length. A series of cross-faults appear to offset bedrock units in a northeasterly direction south Highway 299. Some of these cross faults cut the Grogan fault and are probably younger. Starting at the southeast portion of the watershed and moving generally westward through the drainage are the Klamath Terrane rocks, South Fork Mountain Schist, Coherent Unit of Lacks Creek, Incoherent Unit of Coyote Creek, Redwood Creek Schist, and the Sandstone and Mélange Unit of Snow Camp Mountain.

Early Pleistocene-aged marine and nonmarine deposits of the Prairie Creek Formation underlie a limited area of the watershed northwest of Orick. Modern alluvial deposits cover the bedrock along streambeds in the lower reaches of some tributaries and the mainstem of Redwood Creek, while remnants of older river terrace and marine terrace deposits are locally preserved on elevated fluvial platfoms along Redwood Creek and on wave-cut terraces along the coast.

Where the bedrock is relatively intact, sharp-crested ridges with steep slopes and well-incised drainages tend to develop, while clayey and sheared rock masses generally form rounded hilltops with gentle slopes and poorly developed sidehill drainages. These topographic styles generally correlate with the differing types of mass wasting. Deep-seated rotational slides are common in the Redwood Creek Schist, and earthflows are common in the Incoherent Unit of Coyote Creek. The sandstone and shale of the Coherent Unit of Lacks Creek is generally more competent along the northeast portion of the watershed where deep-seated large landslides are less common and mass wasting commonly occurs in the form of debris slides. Mélange of the Incoherent Unit of Coyote Creek underlies the grasslands and lightly wooded areas present in the northeastern portion of the watershed where large earthflow complexes and gully erosion are common.

Mass wasting by debris sliding is common along the mainstem of Redwood Creek where the valley walls are underlain by the Incoherent Unit of Coyote Creek and Redwood Creek Schist, with the associated development of a broad inner gorge and debris slide slope geomorphic features (Janda and others, 1975). Sediment supplied to streams can vary, depending on the types of bedrock and/or landslides being eroded. For example, debris slides in the Coherent Unit of Lacks Creek are likely to produce coarser grained materials (sands and cobbles), while earthflows in mélange of the Incoherent Unit of Coyote Creek will produce significant amounts of finer grained materials (silts and clays) in response to erosion.

Faulting, Seismicity, and Regional Uplift

The Redwood Creek Watershed region is located in a complex tectonic setting near the junction of three crustal plates (North American, Pacific, and Gorda). The region experiences a high level of seismic activity, and major earthquakes have occurred in intraplate areas as well as along well-defined faults (Dengler et al., 1992). The epicenter of the Eureka earthquake (1955, M 6.1) was located very near the trace of the Grogan fault and may have occurred on one of these faults or within a section of descending Gorda plate at depth.

High rates of regional uplift provide a constant source of sediment to the watershed. Relative uplift of the Prairie Creek portion of the Redwood Creek drainage is estimated at nearly 1000 feet in Quaternary time (last 1.6 million years) (Cashman et al, 1995). Elevated alluvial terraces along the mainstem of Redwood Creek suggest that relatively high rates of uplift persist inland within the watershed. The rapid uplift is probably being accommodated along a system of folds and thrust faults, some of which may not extend upward to the ground surface.

Vegetation

Information on past and historical vegetation conditions is not available to compare changes in the types and condition of vegetation classes. Information on current vegetation was derived from 1994 multi-spectral scan information provided by the USFS remote sensing lab. The vegetation map layer is the source for CALVEG types. The minimum mapping size is 2.5 acres for contrasting vegetation types. Early 2002, an update of this vegetation data based on 1998 imagery will be available. The final draft of this report will incorporate the updated information

Currently there are five vegetation types that account for 87 percent (Table 4) of the vegetation in Redwood Creek. The largest type is Douglas-fir, which covers 58,964 acres. Type classifications of both redwood and redwood Douglas-fir cover a combined area of 56,192 acres. Of these three commercial timber types approximately 21 percent (24,315cres) is preserved as old-growth forests. The remainder of the vegetation) within the Redwood Creek drainage is comprised of 32 different and distinct vegetation types. All of these types have a combined total of 8,000 acres, approximately 13 percent of the watershed area. Table 4 shows all of the vegetation cover types found within Redwood Creek.

Several of these types as shown in Table 4 could indicate a change from the original pre-settlement vegetation. Urban-Developed areas account for 49 acres, mostly the town of Orick. Areas of coyote brush, (*Baccharis spp*.), blueblossom ceanothus (*Ceanothus thyrsiflorus*), and agriculture are vegetation types which may not represent the native vegetation in the total area originally found in the area. Agriculture (420 acres) is a definite change. This change is located mo stly in and round the community of Orick. Blue blossom, an invader species mostly after fires or other ground disturbance, occupies 503 acres. Blueblossom Ceanothus along with coyote brush is found on the dryer south facing sites.

Table 4: Vegetation Types and Acres for the Redwood Creek Drainage.

Vegetation Type	Acres	Percent of Total
Northern Mixed Chaparral	4	Less than 1
Red Fir	11	Less than 1
Ultramific Mixed Schrub	13	Less than 1
Tule - Cattail - Sedge	18	Less than 1
Dune	19	Less than 1
Mixed Conifer - fir	21	Less than 1
Urban - Developed	49	Less than 1
Scrub Oak	160	Less than 1
Jeffery Pine	183	Less than 1
Ultramific Mixed Conifer	205	Less than 1
Coyote Brush	228	Less than 1
Mixed Conifer - Pine	260	Less than 1
Willow	346	Less than 1
Bigleaf Maple	362	Less than 1
North Coastal Mixed Shrub	376	Less than 1
Tree Chinquapin	393	Less than 1
Barren - Rock	413	Less than 1
Agriculture	420	Less than 1
Water	440	Less than 1
Huckleberry Oak	457	Less than 1
Blueblossom Ceanothus	503	Less than 1
Douglas-fir Pine	617	Less than 1
Calikornia Black Oak	667	Less than 1
Canyon Live Oak	839	0.45
Douglas-fir White Fir	1317	0.71
White Fir	1399	0.75
Sitka Spruce	2213	1.18
Montane Mixed chaparral	2733	1.46
Sitka Spruce - Redwood	6153	3.28

Vegetation Type	Acres	Percent of Total
Oregon White Oak	7640	4.07
Red Alder	7898	4.21
California Bay	8957	4.78
Annual Grass - Forbes	10413	5.55
Tanoak - Madrone	16618	8.86
Redwood - Douglas-fir	23139	12.34
Redwood	33053	17.63
Douglas-Fir	58964	31.45
Total Acres	187501	

Hardwood trees species associated with disturbance and land use change are also found within Redwood Creek. Currently red alder (*Alnus rubra*) covers 7,898 acres. Most of this area is located below the Bridge Creek subbasin and generally on the west side of Redwood Creek. The heaviest concentrations of the tree are found in the areas of intense logging activity in the 1970s. Although this species represents approximately 4 percent of the land base within the Redwood Creek basin distribution is limited to the area below Devil's Creek. No significant mappable concentrations are located above this area. Although this species can be found up to 100 miles inland and at elevations below 2500 feet it does not appear to occur above 600 feet in elevation along the main stem of Redwood Creek. Along the upper slopes red alder is not found above 1800 feet along the southern aspects. Another hardwood species, which is associated with land use activity, is tanoak (*Lithocarpus densiflours*). Tanoak can exist under a forest canopy with low light levels throughout most of its life. Once released the suppressed trees exhibit remarkable growth and development. The extensive tanoak stands (16,681 acres) may have developed from the post World War II harvest of the extensive Douglas-fir stands in the Upper Redwood Creek area.

Only the area of barren rock (413 acres), water (440 acres) and dunes (19 acres) are not currently supporting some type of vegetation. The barren-rock areas are scattered around the watershed, except for two large areas. The first larger area is the extensive gravel bars (129 acres) along Redwood Creek along the town of Orick and upstream above the Prairie Creek confluence. The second distinct area (72 acres) follows the new section of Highway 101, commonly referred to as the "bypass".

Fire History

The moist coastal redwood forest has a lower incidence of fire that the drier upland forests within Redwood Creek. Lightning fires do not appear to be frequent near the ocean but their significance as an ignition source increases with the distance from the coast and rise in elevation. Intense fires occur at intervals of greater that 500 years in the more mesic sites (Veiers 1980), 150 to 200 years on the mid-elevation slopes and 50 years at the dryer inland areas.

Fire has long been used as a land management tool within Redwood Creek. Native peoples burned forests on a frequent basis to reduce the fuel loading as an aid to hunting. The use of fire as a management tool was well utilized by the lumber industry. During the steam yarding era, forests within Redwood Creek burned prior to yarding. Generally these areas were burned after the large timber was felled and the bark was removed. Once this was done burning was utilized to remove the significant amount of logging debris. Removal of this debris made the yarding of the logs much easier but resulted in an increase in sediment generation from the burned unit. Fire is used today as part of modern silvicultural practices. Burning of a clear cut unit is utilized for the preparation of the area for planting and regeneration of the site. Burning prescriptions typically use light ground fires to reduce the fine fuels but retain the larger more coarse debris for ecosystem benefits and retention of soil. Redwood National Park also utilizes prescribe fire as part of their management plan.

Table 5: Acres Burned and the Number of Fires by Responsible Agency since 1950.

Agency	Number of Fires	Total acres burned
CDF	7	334
NPS	116	1422
USFS	11	99
TOTAL	234	1855

Within recorded history fires have been a common part of Redwood Creek. As the above Table 5 shows, 1,855 acres have been burned within the drainage since 1950. Due to the difference in reporting methods, the number of fires and the acres burned for the National Park Service (NPS) includes the prescribed fires that Park conducts on an annual basis. Some of these burned areas in the Park reflect grassland, which has been burned multiple times to control unwanted vegetation. It should also be noted that approximately 79 percent of this total resulted from the“Healy Logging Fire” of September 1955. Fires was used as a silvicultural site preparation tool are not reflected in these numbers unless such a fire escaped control lines and required suppression.

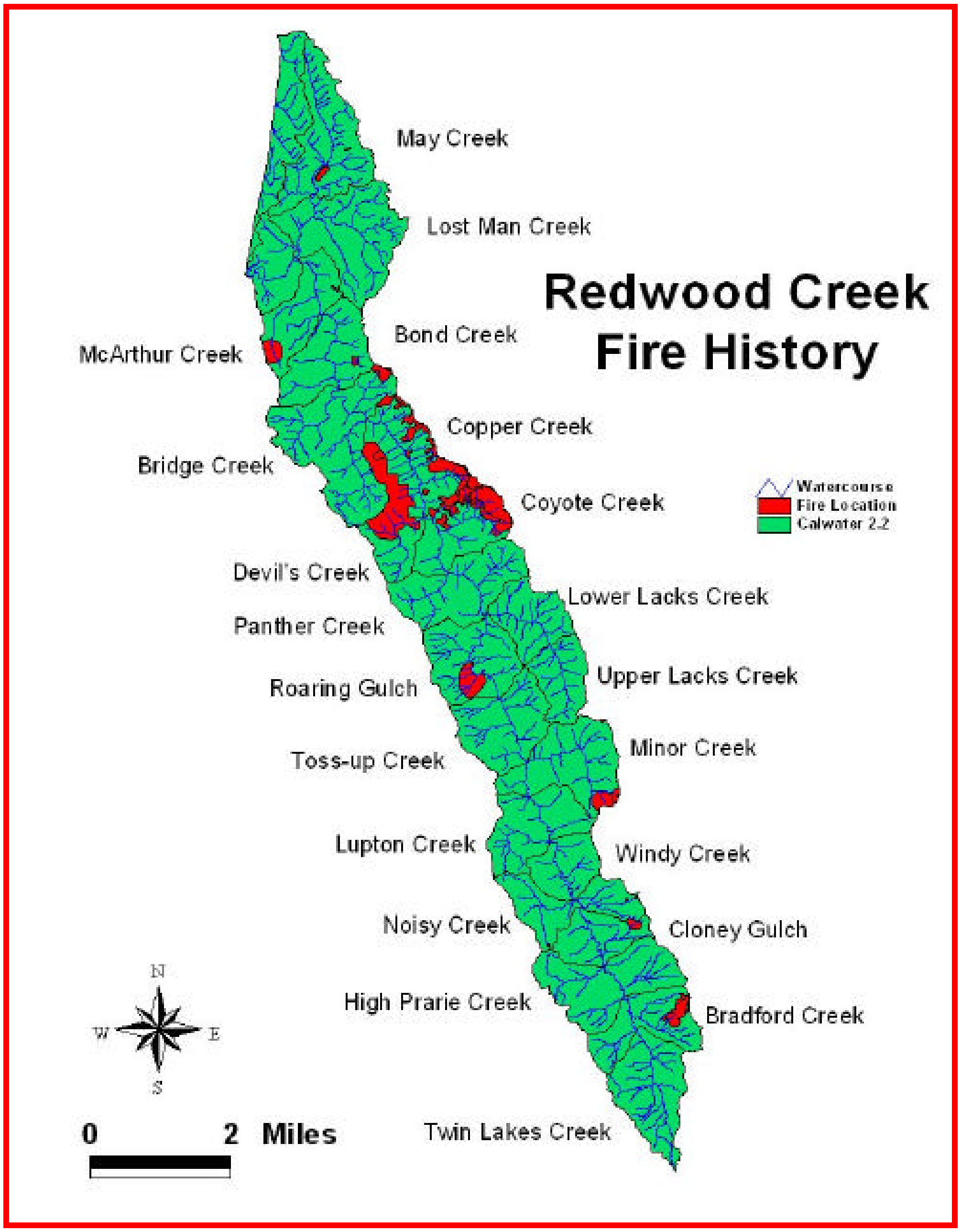

Figure 6: Redwood Creek Fire History Map Showing Burned Area Locations for Fires Larger than 300 Acres.

Early Land Use

Native Americans made extensive use of Redwood Creek, especially along the main channel of Redwood and Prairie Creeks (Foster, Pers Comm.). Extensive villages were located along the flood plain near the mouth of the ocean. The Yurok People have occupied approximately 300,000 acres (Lara 1996) covering the area from the mouth of Little River through the lower portion of Redwood Creek and north to Wilson Creek and inland to Bluff Creek along the Klamath River. T. T. Waterman in his work during the early 1900s (Kroeber 1976) recorded no fewer than five villages during his work on the Yurok Tribe in 1923. The rich forests of this region were teeming with wildlife and the streams were full of fish. Fire was also used as a land management tool. Forests were burned on a frequent basis to reduce the fuel loading as an aid to hunting. Although the Yurok People did not cut down redwood trees a fallen redwood tree or portions of the tree were well utilized. Uses of the redwood tree included; redwood sticks for cooking and drying various fish, for drying meat such as elk or sea lion, construction material for houses or sweat lodges, gill net floats, net needles, drum handles, baby baskets, storage baskets, ladies work dresses, chairs, pillows and the indispensable canoe.

Chilula people inhabited the lower and central portion of Redwood Creek. Chilula villages were located on or near lower Redwood Creek from the inland edge of the redwood belt to a few miles up stream of Minor Creek. Eighteen villages sites were recorded as belonging to these people. All but one (Kroeber 1976) of these sites was located on the eastern side of the creek. This was to take advantage of the of the increased sunlight and less timbered areas.

A third group of Native Americans that inhabited Redwood Creek were the Whilkut people. They occupied upper Redwood Creek area upstream of the Chilula to the headwaters and portions of the Mad River and Grouse Creek drainages.

Settlement of the Orick area was first recorded in the 1850s. The alluvial plain in and around Orick was cleared of the extensive Sitka Spruce stands, hardwood trees and thick brush and converted to farm and grazing land. This converted area accounts for less than one percent of the total basin area. The upper areas of Redwood Creek were becoming utilized and populated during this same time period. Miners and settlers were moving into the basin. The initial use of hardwoods in this area was for fuel wood, fence posts, and tanbark. Tanbark, bark from the tanoak tree was used for the tanning of hides.

Cattle ranching and sheep farming were beginning to utilize the native meadows, grasslands and oak woodlands. Cattle were being moved into the Redwood Creek area and by 1860 extensive herds were located along the Bald Hills and Upper Redwood Valley. After 1865 the sheep and wool industry became the leading agricultural enterprise in the eastern portion of the valley, away from the dense stands of timber. Excellent stands of native grasses provided year-round grazing and were well suited for sheep grazing. Wool produced in this area of Humboldt County was considered to be the best grown on the Pacific Coast and always brought the highest prices on the open market (Green 1980). Up until 1940 there was an estimated 15,000 to 20,000 sheep within the Bald Hills and Redwood Creek area (Stover, pers com). With this large number of animals within a relatively small area one can only speculate as to the amount of impacts from this enterprise. The only land base, which could be used for grazing, was the natural grasslands and oak woodlands. These two areas amount to approximately 32,000 acres of suitable rangeland. These figures would indicate that there were approximately 1 to 2 sheep per acre. This figure is well above the recommendation of no more that one animal per four acres. Once the carrying capacity of the range is exceeded and the area is overgrazed, adverse effects can be noted: reduced forage production, creation of bare and unstable topsoil, loss of top soil, increased erosion, creation of gullies, invasion of the site by lower quality plants, increase in the percentage of annual plants and reduction in the number of plant species present.

Land Use and Ownership

Prior to 1968 most of the Redwood Creek drainage was held in private ownership. Timber companies or large family ranches owned most of this area. During this time timber management was the dominant land use. Creation of the Redwood National Park in 1968 and expansion ten years later led to a change of land use within the Redwood Creek area. Logging was no longer the principal land use in the lower part of the drainage.

Currently 43 percent of the entire watershed is within public ownership. Privately held timberlands account for 56 percent of the ownership (101,142 acres) within the Redwood

Creek Basin. The Redwood Creek Landowners Association is comprised of ten private landowners (Landowners Association 2000) ranging from small to large industrial tracts, that own and manage lands within Redwood Creek. This collective ownership accounts for more that 80 percent of the privately owned property in the watershed. Eight large ownerships of larger than 3,000 acres each account for 90 percent of this total. Some of these members have managed land within the basin for fifty years or longer. These landowners practice a mix of land uses, including ranching and forest management.

Table 6 outlines the percentage of ownership for the four main public agencies with land management responsibilities within Redwood Creek. These figures represent a consolidation of the ownership patterns that existed at the beginning of the 20th century. The 1911 "Denny's Official County Map" shows property ownership of Humboldt County and reveals a much more fragmented land ownership pattern for the Redwood Creek area. Land sections are divided up into multiple ownerships with each section containing as many as six ownership names.

Table 6: Acres and Percentage of Ownership within Redwood Creek (From Redwood National Park)

		BASIN	FED Only
National Park	66,696 ac	36.9%	92.7%
State Park	6,620 ac	3.7%	
BLM	3,599 ac	2.0%	5.0%
USFS (Six Rivers)	2,537 ac	1.4%	2.3%
Private	101,142 ac	56.0%	
Total	*180,594 ac*	*100.0%*	*100.0%*

As the demand for forest products increased by 1950 and timber operations became the principal land use within Redwood Creek, companies began to increase their land base. Smaller companies and individual holdings were bought up or the timber rights were acquired by the larger more viable operations. As a result of this ownership consolidation almost all of the privately held land became subject to forest management and timber harvests.

Table 7: Redwood Creek Subbasin Summary.

	Redwood Creek Subbasin Summary					
Basin	**Estuary**	**Prairie Creek**	**Lower**	**Middle**	**Upper**	**TOTAL**
Area (ac.)	3,429	25,338	44,487	64,090	43,342	180,686
Roads (mi.)	58	271	327	461	382	1,499
Acres Harvested	563	8,521	28,654	40,059	17,427	95,197
Hardwoods	417	1,204	8,452	11,412	14,304	35,789
Grassland	0	312	752	4,016	3,889	8,969
Forested	1,302	23,774	34,716	48,186	22,638	130,616
Converted Acres	1,710	48	0	20	0	1,778
Stream (mi.)	45	91	130	192	141	599

Forest Management

Initial timber harvests in the Redwood Creek basin are visible on the 1942 aerial photos. This early logging was conducted with steam donkeys and cable systems as evident from the telltale yarding patterns in the photos. Some early tractor logging started in the late 1930s, but this method does not become highly utilized until after the end of World War II. The post war years and associated housing boom created an increase in the demand for Douglas-fir logs. This led to an increase in logging within the middle and upper portions of Redwood Creek. During the period from 1949 to 1954 19 percent of the area was logged (Best 1984). This increased harvest of Douglas-fir stands, with little or no attention played to their regeneration, resulted in a significant area of tanoak stands, which are visible in the area today (Houston). Today, these almost pure tanoak stands are being harvested and replanted to the Douglas-fir.

Modern cable yarding methods did not become well utilized within Redwood Creek until around 1972 when Arcata Redwood Company brought in the first highlead system (Hooven pers com). Introduction of cable yarding systems along with the newly legislated Forest Practices Act of 1972 modified somewhat how timber was yarded within the drainage. There was an increase in the use of ridge top landings and mid-slope road construction. Clear-cutting units were reduced in size from the massive cuts of the 1950s to areas typically less than 80 acres each. Buffers between clear-cut blocks were also utilized during this time period as part of the new Forest Practice Rules. Changes on the ground can also be seen on the aerial photos that are the result of regulatory change. The popular use of "cable below the road and tractor above" is quite evident during this time and up until the early 1990s. With the addition of stream protection zones in 1984 to the regulatory toolbox, these protection measures become quite visible on the photos after that time.

Detailed assessment of timber harvesting history was completed with the use of several data sources. Aerial photos for 1942, 1948, 1952, 1954, 1958, 1964 and 1977 were utilized to determine past harvest areas. For the decades of the 1980s and 1990s actual timber harvest plans, spatially captured in GIS, were utilized along with satellite multi-spectral scanned image data (MSS). This MSS data was used to indicate changes in the vegetation and not just timber harvesting. Table 8 below reflects the cumulative amount of timber harvesting within Redwood Creek (excluding Prairie Creek—logging within the Prairie Creek subbasin appeared to have stopped about 1968) as a percent of the total area. By the end of 1948, approximately five percent of the basin area had been logged. In the period from 1949 to 1954 16 percent of the area was logged (Best 1984). During this period logging was very severe but still differed throughout the drainage. Over half of the forestry operations took place in the middle portion of the watershed. Half of the acreage cut was from the upper third of the basin. During this period harvesting was very active in the Prairie Creek and May Creek areas with extensive clear-cuts visible on the 1954 photos.

Table 8: Cumulative Harvest Percentage of Original Forests Within Redwood Creek, excluding the Prairie Creek Area, for Key Years.

Cumulative Harvest (Basin excluding Prairie Ck)	
Year	**Percent**
1948	5
1954	21
1962	35
1978	62
2000	64

From about 1954 to 1978 the rate of harvest within the Redwood Creek area remained fairly constant. Although there were annual fluctuations in the harvest from area to area the annual harvest was approximately 3000 acres per year. After 1966 the upper and middle areas had a drop in the areas harvest but the lower area of Redwood Creek harvest rate more that doubled. Prior to 1964 access roads were constructed along the bottom of Redwood Creek and along some of the tributaries. These new access roads allowed for new logging areas to be opened up prior to the 1964 storm event. Most of the areas cut prior to 1970, as visible on the air

photos are in larger clear-cuts few in number. By the end of 1978, 62 percent of the Redwood Creek land base had been logged. At this time logging had stopped in the lower third of the basin. Along the upper two thirds of the watershed relogging of previously entered areas was being conducted.

Table 9: Cumulative Harvest Percentage of Old-Growth Forests Within Redwood Creek, excluding the Prairie Creek Area, for Key Years.

Cumulative Harvest (Basin excluding Prairie Ck)	
Year	**Percent**
1948	5
1954	21
1962	35
1978	62
2000	64

From about 1954 to 1978 the rate of harvest within the Redwood Creek area remained fairly constant. Although there were annual fluctuations in the harvest from area to area the annual harvest was approximately 3000 acres per year. After 1966 the upper and middle areas had a drop in the areas harvest but the lower area of Redwood Creek harvest rate more that doubled. Prior to 1964 access roads were constructed along the bottom of Redwood Creek and along some of the tributaries. These new access roads allowed for new logging areas to be opened up prior to the 1964 storm event. Most of the areas cut prior to 1970, as visible on the air photos are in larger clear-cuts few in number. By the end of 1978, 62 percent of the Redwood Creek land base had been logged. At this time logging had stopped in the lower third of the basin. Along the upper two thirds of the watershed relogging of previously entered areas was being conducted.

Recent Harvest Methods – 1977 to 2000

Timber harvesting has continued within the area of Redwood Creek, up stream of the National Park boundary since the expansion of the Park. This section of the assessment was not broken down by subbasins as in the THP assessment due to the similar management activities, road systems and common ownerships within the two subbasins. Of the 107,000 acres above the Park boundary, approximately 54 percent was harvested during a 24 year time span. From the period of 1977 to 2000, approximately 58,000 acres operated on. On average, 2,423 acres per year were harvested during these 24 years.

A total of 419 harvest plans were reviewed and approved by the Department of Forestry and Fire Protection between 1977 and 2000. During this time period the number of timber harvest plans approved on an annual basis has decreased. Average plan size has increased. During the late 1970s the average plan size was approximately 80 acres. By 1998 the average plan size had increased to 187 acres. Part of this change may be due to the change in silviculture prescriptions and regulatory changes. The peak of 54 plans in 1978 has decreased to the current low of less than 10 per year. A portion of the reduction in plan number may be explained by the changes in timber type and size. Present day timber size and density indicates there is not a large amount of commercial size timber acreage available for harvest. The peak of acres harvested was in part due to the increase in economic conditions. The large spike in the graph for the acres harvested in 1993 is the partial result of several plans being submitted for a relatively large number of acres. Rehabilitation of understocked (Rehab) areas was employed on several large areas. Commercial thinning and sanitation salvage were employed to a limited extent.

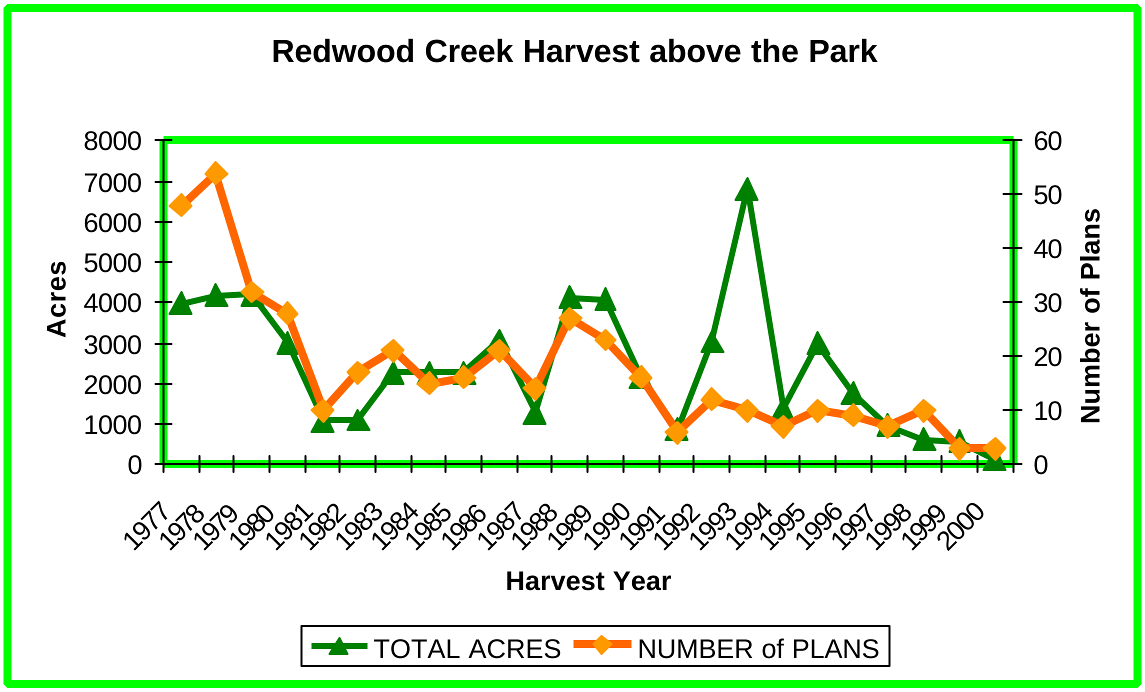

Figure 7: Redwood Creek Harvest above the Park for the Years 1977 to 2000.

Silviculture and Yarding

Silviculture and yarding changes were also assessed for the middle and upper subbasins of Redwood Creek. Twelve separate silviculture prescriptions and intermediate treatments were utilized during the 12-year period from 1989 to 2000. Clear cutting (CLCT) accounted for the largest area treated. Although clear-cutting is still heavily employed, its overall use appears to be decreasing in the upper Redwood Creek area. For the 24-year period 29.7 percent of the acres harvested were clear-cut. Rehabilitation of understocked (REHB) areas was employed on 16.4 percent of the acres harvested. Use of this silviculture prescription is employed to reestablish conifers on hardwood-dominated. This treatment is used mainly on industrial timberland. The extensive tanoak stands developed from the post World War II harvest of the extensive Douglas-fir stands found in the middle and upper Redwood Creek subbasins. Recent years have seen the increased use of other silviculture methods and treatments. Commercial thinning (CMTH) and selection harvests (SLCN) are increasing during the recent years as compared to the decade of the 1970s. Selection harvest was applied to 5.6 percent of the areas harvested. Generally, use of this silviculture system is limited due to the lack of all age stands found within the upper basin area. Areas of "No Harvest" (NHRV) is another forest management tool, which has become utilized during recent years. These areas are utilized for wildlife protection measures and came on the scene during the mid 1990s. The limited use of sanitation – salvage (SASV) would indicate the overall health of the forest is in good condition. Increased use of the commercial thinning intermediate treatment is expected in the future. The young growth stands are well stocked and may require intermediate treatments to increase forest growth and yield.

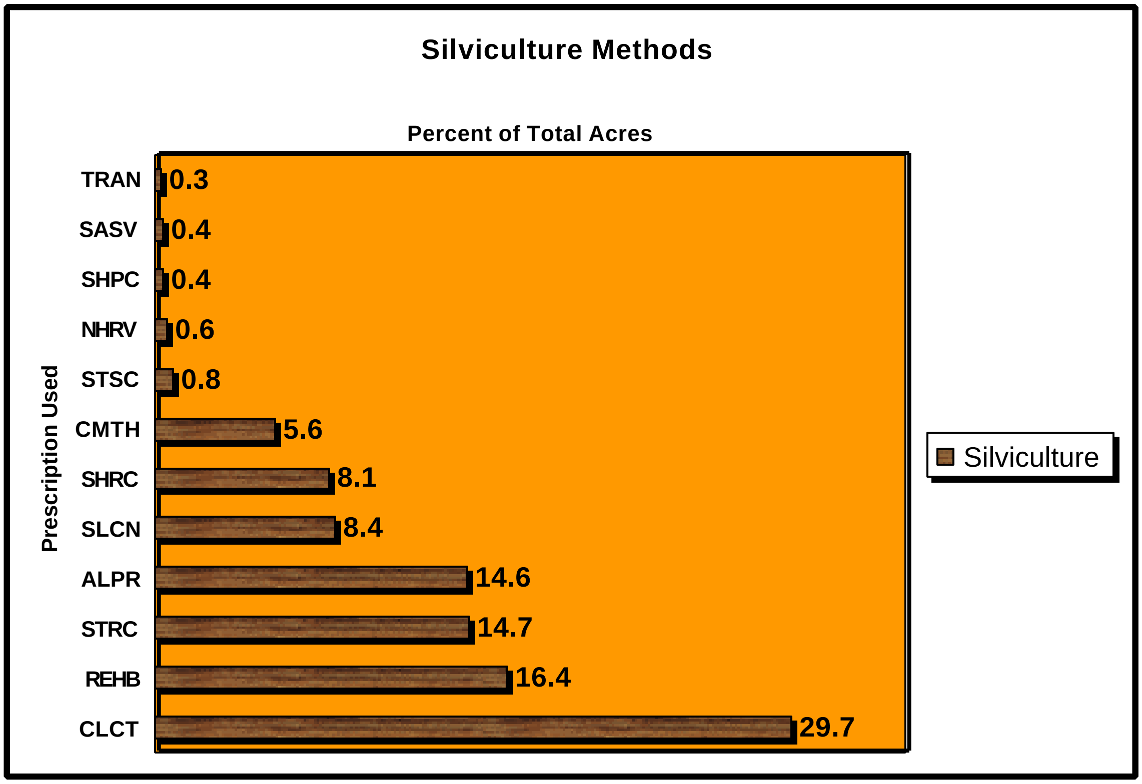

Figure 8: Upper Redwood Creek Silviculture Methods and Intermediate Treatments for the Years 1989 to 2000.

Alternative prescriptions (ALPR) was applied to 14.6 percent of the harvest plans. These alternative prescriptions usually resembeled a shelterwood removal or clear-cut. As an alternative to the standard prescriptions these methods were used to protect components of forest resourcses which could not otherwise be safe garded. Areas generally safeguarded were generally associated with wildlife issues or watercourse portection measures. Use of a shelterwood removal cut (SHRC) along with the seed tree removal cut (STRC) was usually applied to areas in which the residual timber was to be removed. Well stocked understories are required in the Forest Practice rules for these two prescriptions to be applied. The remaining prescriptions were utilized on a limited basis. Their use would appear to be on a very site explicit basis to achieve a desired stand result.

Yarding methods employed on timber harvest plans within the middle and upper Redwood Creek area are divided into three separate systems. Ground based skidding accounts for 77 percent of this total. Of the approximately 58,000 acres harvested 44,600 were yarded with ground based equipment. Cable yarding systems were used to yard an additional 9850 acres. This category includes all types of cable yarding systems. Helicopter yarding was utilized for the yarding of six percent of the plan area. Most of the helicopter yarding was used in clear-cut or shelterwood removal units. Ground based yarding was used in all types of silviculture units. Cable yarding appears to have been limited to rehab units, shelterwood removal areas and clear-cuts. Cable yarding was used in one harvest plan to yard several small commercial thinning units.

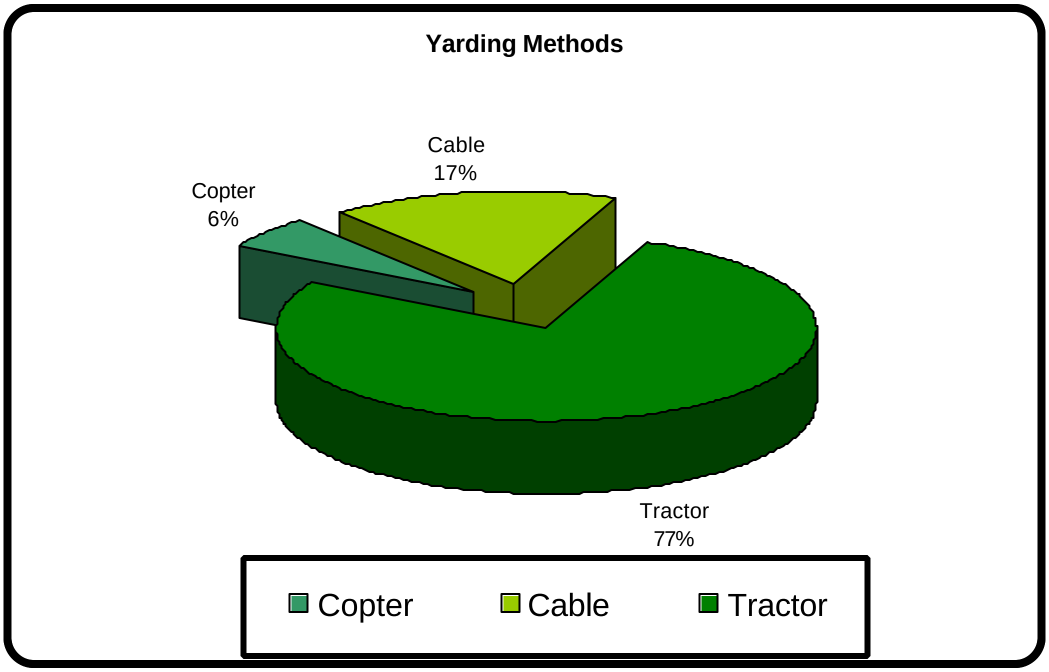

Figure 9: Middle and Upper Redwood Creek Subbasins Yarding Systems Utilized During the Period of 1989 to 2000.

Review of the harvest plan locations in relation to their position on the slope was also assessed. Harvest plans for the past ten years were overlaid on a digital elevation model. Generally the cable yarding operations were utilized on the slopes greater than 50 percent. Cable yarding was also used to span watercourses due to limited roads access to one side or the other. These areas appear to be deep narrow canyons where cable suspension could be maintained. Helicopter yarding was used to access areas of steep slopes and in selected area where access was limited.

Roads

There is approximately 1,700 miles of roads within the basin of Redwood Creek. Redwood National Park has estimated that about 50 miles of roads are located within the inner gorge of a watercourse. Only the major highways and several county roads are paved. The remainder of the roads within the drainage are surfaced with either native material, gravel or rock from a local source. In addition, the majority of these road (66%) (RNP 2001) were constructed prior to 1964. Between 1964 and 1978 14 percent of the roads were build. An additional 20 percent were added between 1978 and 1992.

Road density information in the KRIS along with Cedarholm et al. (1982) suggest that fine sediment increase in watersheds with more that 3 miles of roads per square mile of area. Currently Redwood Creek has approximately 4.79 miles of road per square mile for the entire watershed. This number drops to 2.15 miles of road per square mile of area within the State and National Parks. Up stream of the Park this road length per square mile increases to 6.72 miles of roads per square mile on private ownerships. The USFS and BL M ownerships in Redwood Creek have 4.80 miles of road per square mile of ownership.

The road-decommissioning program within the National Park has treated or removed 214 miles of roads since the program began in 1978. Road assessment for the Redwood Creek basin has been completed or is nearing completion. Assessment work in Lupton Creek, Noisy

Creek, Pardee Creek, Toss Up Creek and Roaring Gulch are planning watersheds which have been funded. The immediate objective of this watershed improvement-planning project is to develop site-specific projects that address the most significant factors negatively affecting habitat for anadromous salmonids in this portion of the Redwood Creek watershed. The long-term objective is to complete an assessment and planning effort for all private lands in Redwood Creek so that a single restoration plan can be developed for the entire basin. With the funding and implementation assessment program, roughly 90% of the private lands in Redwood Creek will have been inventoried. The remaining portion containing smaller, mixed ownerships would be submitted for funding during the next funding cycle.

The vast majority of the roads in the watershed were constructed during the initial timber harvest period. Most of the private road construction was for the purpose of timber harvesting. With changes in the forest Practice Regulations new construction has to meet a higher standard. These regulations cover construction activities such as operations on steep slopes, road alignment, road grads, erosion control, watercourse crossings, culvert instillation, winter period operations and road maintenance. This project is specifically intended to provide a prioritized plan for reducing the affect of the roads on stream channels. Roads currently used for access to conduct timber harvest operations may be upgraded by the landowner. Some landowners have already taken action to upgrade many of their roads and watercourse crossings. The recommendations and findings of this road assessment work should be included in the final Redwood Creek Assessment Plan.

Although the new construction undertaken by CALTRANS was for a new freeway by-pass, this project did account for excessive amounts of runoff and sediment production by the time the project was finished in 1992. Impacts of concern occurred during a heavy rainstorm in October 1989.

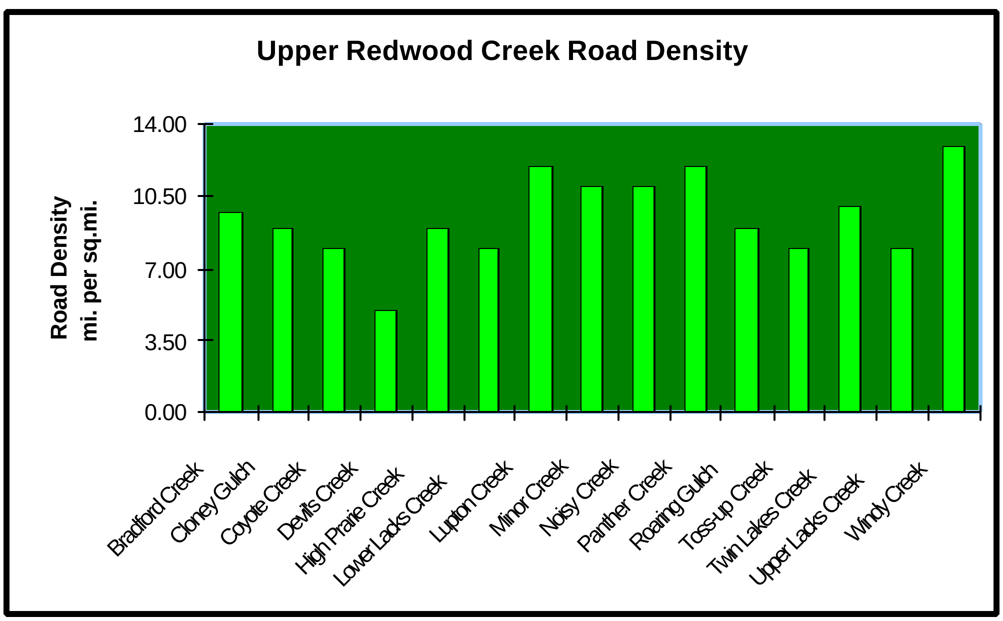

Figure 10: Road Density for Selected Planning Basins within the Middle and Upper Basins of Redwood Creek.

Fluvial Geomorphology

DMG did only a limited study so far of the fluvial geomorphology of the Redwood Creek watershed. We reviewed and compiled data for the entire watershed at 1:24,000 from aerial photographs (1984 and 2000) and some existing reports (for example, Madej, 1984).

DMG plans to review and interpret additional aerial photographs decade by decade to identify and compile changes in the locations and sizes of stream bars, streamside landslides, and sediment-widened stream channels. Aerial photographs are available from the 1940s, and partial coverage exists from the 1930s. Air-photo data will be compiled into a GIS database for analysis in ArcInfo and ArcView.

Hard-copy paper maps of fluvial geomorphology will accompany landslide maps in a later version of this watershed assessment in the spring of 2002. For computer viewing, information from each photo year will be presented as multiple shape files in a DMG database (layers in ArcView); changes in fluvial geomorphology will be viewable to compare the pattern of stream bars and streamside landslides in 1984 and earlier years with those identified in the latest photos - 2000. This information will be available to the public.

Fluvial geomorphology is being interpreted and compiled consistently at the same initial scale for the entire watershed. This will allow end users to compare fluvial features with geologic bedrock and larger hillslope landslides on a watershed scale, by planning watershed, and in specific areas. Individual bars and slides might be attributed and available for study in the database, depending on how much information is made available by Redwood National and State parks and how much time the DMG staff has to devote to the project. In the past, information in Redwood Creek has been fragmentary, scattered and difficult to obtain with the exception of the papers available in USGS Professional Paper 1454. Hopefully, with cooperation from all involved, this assessment will make existing and new data more readily available to a wider audience and form a basis for restoration and management decisions.

Our study is incomplete to date because of unavoidable time limits, budget constraints, and limitations in the availability of existing data. We have mapped and compiled fluvial features from aerial photographs from 1984 (scale of 1:31,680) and 2000 (scale of 1:24,000). We have done some photo review from 1965 (1:24,000), which is far from finished at the date of this draft. We probably will not have time to review photos from 1937, 1947, and 1955, because of current deadlines, though such a study would provide local baseline and storm/timber harvest conditions. Comparison of present and past conditions will show the extent of improvements in the watershed following storm events in 1964, 1972 and 1975, as well as the smaller storm of 1996/1997. A thorough review of all photos can show the extent of devastation during the past large storms. Evaluation of the earlier photos will show the effects on the mainstem and tributary channels of land use and large storms. Study of pre-1945 photos would be very useful for comparison with post-storm conditions and with more recent conditions in 2000, because before 1945, 85% of the basin was covered with old-growth redwood and Douglas fir (Best, 1995).

This work focused on mapping stream features associated with sediment transport, storage and source areas within the watershed and compiling these at 1:24,000, which is the scale of the standard USGS 7.5-minute topographic map familiar to many. Sediment transport and storage areas were evaluated by mapping the network of gravel bars and terraces and delineating widened channels under the assumption that widening is due to excess sediment. Stream bars and widened channels were mapped as bare (active in that photo year) or vegetated (less recently active and not active in that particular year). Source areas were evaluated by mapping streamside landslides and hill-slope gullies. Slides were also mapped as bare or vegetated, because even vegetated slides have been active very recently in a geologic sense. We assume that these vegetated slides, bars and channels have been active within the last fifty to one hundred years.

We have not field checked our aerial photograph reconnaissance mapping due to time and budget constraints and we consider that to be a serious flaw in our summary to date.

A broad level description of major stream types was conducted based on the Rosgen method (Rosgen, 1996). This method provides a general characterization of valley types and landforms, and provides criteria to identify corresponding stream types. The Rosgen method is relatively simple to use and explain others. DMG has not field checked Rosgen channel type assignments, though DFG used this method to classify the channels in their field-study reaches.

The general stream geomorphic characteristics for Redwood Creek Watershed were evaluated using a computer model of the topography and stream gradients. This work provides an initial sorting within the watershed based on valley types and related landforms and allows a general level of interpretation of stream types based on the general features of dimension, pattern, generalized longitudinal profile, and materials of the modern river. Estimates of bankfull stream geomorphology were made using regional equations developed by Rosgen and Kurz (2000, written comm.), and are currently being compared with actual channel measurements from DFG field crews. Channels studied include A, B, C, D, and F Rosgen types. A+ stream types, which have stream gradients above 10%, predominate in the upper and middle portions of the tributaries to Redwood Creek. Commonly, these shallow to entrenched F-type channels toward their confluence with the mainstem.

An objective was to observe whether stream reaches exhibiting features of potential channel disturbance are adjacent to areas underlain by much larger dormant and/or historically active landslides. So far our work shows that active streamside landslides are abundant in some of the areas of dormant or historically active landslides. It is possible that mapping of fluvial features will show where and when the larger features are more active. Variations in activity over time might be due to changes in rainfall, streamflow and patterns of groundwater movement.

The portions of channels mapped as potentially disturbed generally decreased slightly during the period from 1984 to 2000, though some local reaches had an apparent increase in disturbance. Stream bank erosion and shallow landslides associated with near-channel roads appear in both sets of photos from 1984 and 2000

Past studies indicate that streamside landsliding and fluvial hillslope erosion by gullying may be the most important processes delivering sediment to Redwood Creek (Harden and others, 1978; 1995; Kelsey and others, 1981a; 1981b). Streamside slides and gullies are among the features we are mapping.

Streamside landslides are clearly an important source of sediment in the Redwood Creek watershed, because of their number and volume, and because they deliver sediment directly to channels (RNSP, 1999). Streamside landslides include debris slides, debris avalanches, and earthflows; however, debris slides account for most of the streamside landslide volume (Kelsey and others, 1995). The erosional landform map of Nolan and others (1976) shows streamside landslides along most of the mainstem and major tributary channels in the upper and middle basins. Streamside landslides may be caused in part by channel aggradation (Janda and others, 1975). Sediment deposited in the channel raises water levels during storms, resulting in undercutting of steep hillslopes that subsequently fail as debris slides. Earthflow activity may be initiated or accelerated by fluvial erosion where the toes of earthflows protrude into stream channels.

DMG's evaluation of gullies resulted in a good spatial correlation between gully formation and areas underlain by dormant and/or historically active earthflows and earthflow amphitheaters. Earthflows may be largely natural erosional features. However, Kelsey (1978) suggested that livestock grazing and subsequent conversion of prairie vegetation from perennial long-rooted native bunch grasses to annual short-rooted exotic grasses may have accelerated or triggered earthflow instability within the past century. Road construction has accelerated gully erosion on earthflows (Walter, 1985). Through interception of subsurface flow, road construction, may have altered streamflow peaks, patterns of groundwater flow, and hence earthflow movement (RNSP, 1999).

On logged hillslopes, extensive networks of rills and gullies have developed from streamflow diversions and washouts at road and skid trail stream crossings, from ditches and cutbanks, and from interception of subsurface flow along roads and trails (Janda and others, 1975). Though gullies can be mapped on air photos, these features are harder to identify outside prairies; they might be under-represented in our maps. Estimates of past road-related fluvial erosion indicate that gullies resulting from stream diversions at road-stream crossings accounted for roughly four times more sediment than erosion where roads cross streams (RNSP, 1999).

Water Quality

Past and current water quality data were evaluated regarding compliance to water quality objectives in the North Coast Regional Water Quality Control Board's (NCRWQCB) Basin Plan. Those same water quality data, as well as sediment and habitat data, were evaluated against TMDL targets for Redwood Creek and data dependency relationships (ranges and thresholds) for the knowledge-based EMDS evaluation model described in a subsequent section. The specific water quality thresholds and ranges (objectives, TMDL targets, EMDS ranges and thresholds) are detailed in the NCRWQCB Water Quality appendix report to the Redwood Creek NCWAP 2001 Synthesis Report

Water Column Chemistry

Water quality metrics in the middle and lower basin over the past 30 years have been within optimal ranges. Unfortunately, no chemical data exist upstream of the Highway 299 bridge where sampling is difficult due to poor access. Applicable Basin Plan water quality objectives for Redwood Creek are: (1) dissolved oxygen minimum of 8mg/L; (2) specific conductance 90^{th} percentile less than 220mg/L and 50^{th} percentile (median) less than 125mg/L, and (3) pH between 6.5 and 8.5.

Dissolved oxygen, conductivity and pH sampled from about 40 stations in the watershed by the USGS from 1960-1980 and at Orick from 1958-1988 by the EPA are within Basin Plan limits. Alkalinity, nitrogen, phosphorus and other parameters have been sampled at some USGS stations but have not shown levels of concern to water quality for salmonids or for human consumption. Anderson (1988) and Woods (1975) data do not show water chemistry parameters at levels of concern to water quality. Since these parameters are variable it is difficult to see trends in the data without consideration of a number of factors, such as time of day, flow, and temperature. The Redwood National and State Parks noted a downward trend in suspended sediment loads at both the Orick and O'Kane gaging stations since 1970 in their Redwood Creek Watershed 1997 Analysis (RNSP 1997). Decreasing suspended sediment in the water column may improve conditions for salmonid production and/or indicate the rate of sediment activity in the watershed.

Thirty years of water chemistry monitoring characterizes Redwood Creek as a moderately hard water, moderately oligotrophic stream, with adequate water quality to support salmonid populations. Nothing can be concluded about the quality of water from the upper portion of the watershed due to a lack of sampling sites, except that water quality at the first station below the upper subbasin is good. Dissolved oxygen and pH values do not change much from one subbasin to another. Conductivity in Prairie Creek was slightly lower in the 1970s compared with the rest of the watershed. Nutrients (nitrogen and phosphorus) are low. Water quality in the estuary is difficult to characterize, but there exists a multitude of points for water condition as the mainstem enters the estuary. Because of heightened interest in this watershed, we are fortunate to have 30 years of water chemistry data to detect some changes over time.

Water Temperature

The temperature range for "fully suitable conditions" of 50-60F(10-15.6C), described in the NCWAP Methods Manual NCRWQCB appendix, as well as in the EMDS model appendix, was developed as an average of the needs of several cold water fish species, including coho salmon and steelhead trout. For sites throughout the watershed, MWATs calculated from summer raw temperature data from 1994 to 2001 are borderline or exceed the "fully suitable" range. Historically and today, temperatures in Redwood Creek basin show maximum MWATs for the period of record along the mainstem ranging from 67-72F and tributaries in the 54-68F range.

The mainstem reaches, especially in the middle section of the basin, experience the highest temperatures perhaps due to wide channels with little to no canopy cover and a NW/SE aspect. Throughout the basin, cold water tributaries help to ameliorate increases in, and in some cases, lower mainstem temperatures. Overall, the headwaters area of Redwood Creek and the Prairie Creek subwatershed are the coolest perhaps due to cold water inputs from tributaries with tall streamside trees and steep inner gorges which provide shading over the channel. Improvements in riparian vegetation and protection of cold water flows can help to reduce water temperatures, recognizing that some channels in the basin may be too wide to support riparian vegetation dense and tall enough to fully shade the channel and that cold water flows from tributaries may be insufficient to impact mainstem temperatures. It is also recognized that shade provided by dense canopy cover over the channel maintains cool water, but does little to lower temperatures.

For such a large watershed with numerous tributaries, the Redwood Creek basin is well monitored for temperature. Some data gaps exist, but overall one can paint a fairly good picture of what summer water temperatures have been like in the last seven years thanks to great monitoring efforts and cooperative landowners.

See Table 10 which shows maximum MWATs for the Redwood Creek basin, Figure 11which shows a plot of these.

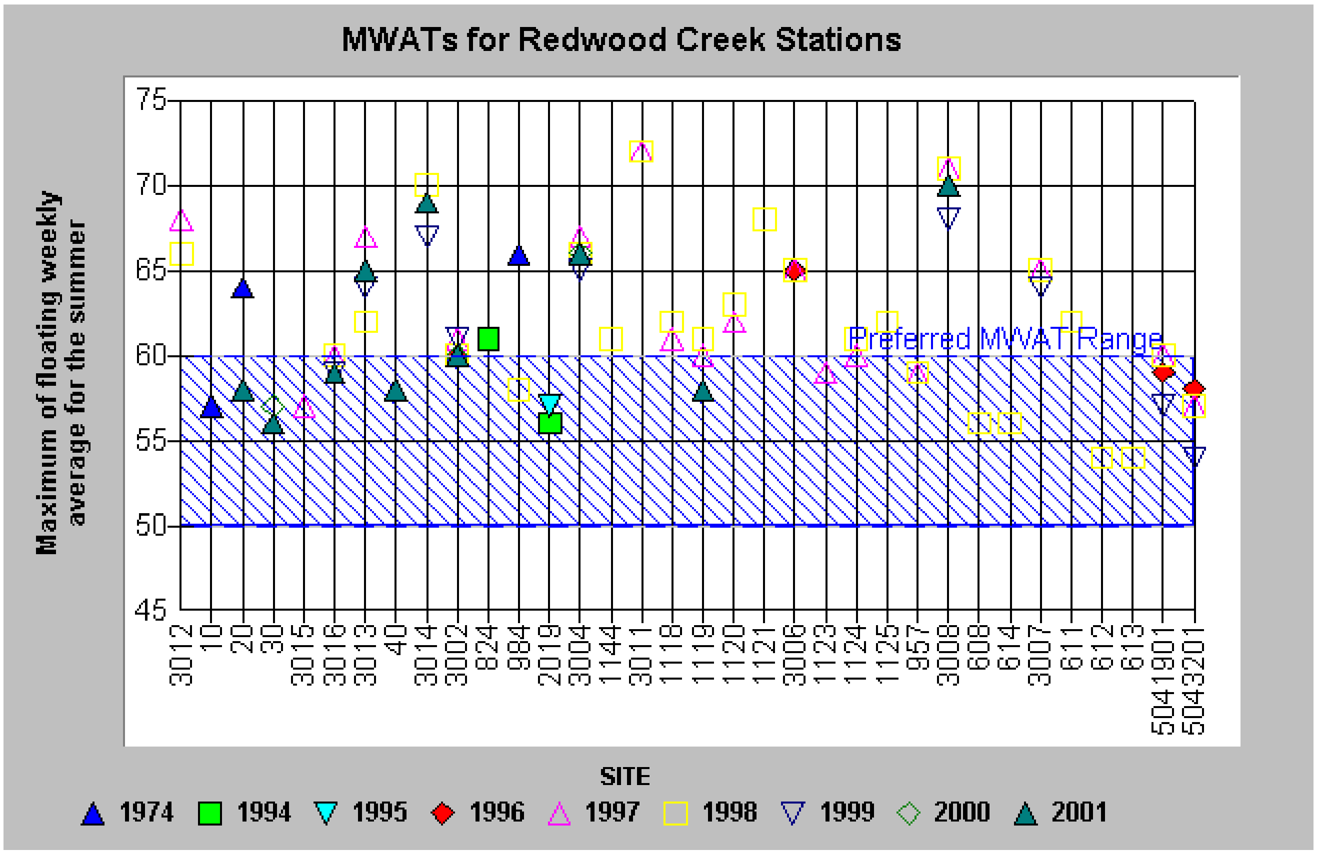

Figure 11: MWAT Temperatures for all Stations in Redwood Creek from 1974 to 2001.

Data Sources: RNSP (2001), Lewis, et al (2000), Simpson (2000). See Table 10 for station locations.

Table 10: Maximum MWATs for all Stations in the Redwood Creek Basin from 1974 to 2001.

Site Name	Creek	Years Sampled	Max MWAT year	Max MWAT
3012	Estuary[5]	1997-98	1997	68
Little Lost Man (10)	Little Lost Man[3]	1974	1974	57
Lost Man (20)	Lost Man[3]	1974	1974	64
Lmc (20)	Lost Man[1]	2001	2001	58
Ldc (30)	Larry Dam Creek[1]	2000, 01	2000	57
3015	Prairie Creek[5]	1997	1997	57
3016, prw	Prairie Creek at Wolf Bridge[5, 1]	1997-99, 01	1997	60
3013, RwLow	*RedCrk upstm Prairie Creek[5, 1]	1997-99, 2001	1997	67
Tmcd (40)	Tom McDonald Creek[1]	2001	2001	58
3014, RwTtg	*RedCrk upstm Tom McD Crk[5, 1]	1997-99, 2001	1998	70
3002, Bri	Bridge Creek[5, 1]	1996-2001	1999	61
824	Coyote Creek[5]	1994	1994	61
984, Panther	Panther mouth[5, 1]	1974, 1998	1974	66
2019	Upper Panther Creek[5]	1994-95	1995	57
3004, Lac	Lacks Creek[5, 1]	1997-2001	1997	67
1144	Upper Lacks Creek[5]	1998	1998	61
3011	*RedCrk upstm Lacks Creek[5]	1997-98	1998	72
1118	Beaver Creek[5]	1997-98	1998	62
1119, Mill	Mill Creek[5, 1]	1997-98, 2001	1998	61
1120	Molasses Creek[5]	1997-98	1998	63
1121	Moon Creek[5]	1998	1998	68
3006, 1145, Min	Minor Creek[5, 1]	1997-98, 2001	1998	65
1123	Minor Creek Trib[5]	1998	1998	59
1124	Upper Minor Creek[5]	1997-98	1998	61
1125	Sweathouse Creek[5]	1998	1998	62
957	Lupton Creek[5]	1997-98	1998	59
3008, RwOkn	*O'Kane gaging station RedCrk upstm Lupton Creek[5, 1]	1997-99,2001	1998	71
608	High Prairie Creek[5]	1998	1998	56
614	Upper High Prairie Creek[5]	1998	1998	56
3007, RwMin	*RedCrk upstm Minon Creek[5, 1]	1997-99	1998	65
611	Minon Creek mainstem[5]	1998	1998	62
612	Upper Minon trib[5]	1998	1998	54
613	Upper Minon Creek[5]	1998	1998	54
5041901	Lake Prairie Creek[6]	1996-99	1998	60
5043201	Pardee Creek[6]	1996-99	1996	58

Data sources: [1]RNSP (2001), [3]Woods (1975), [5]Lewis,T., et al (2000), [6]Simpson (2000)
* are locations on mainstem Redwood Creek
(#) correspond to locations in the MWAT chart, Figure 1

In-Channel Sediment

Redwood Creek was listed by the State Water Resources Control Board as being impaired by excessive sediment since 1996, and a TMDL for sediment was completed by the Environmental Protection Agency in 1998. The Redwood Creek TMDL includes targets for percent fines of less than 14% of fines <0.85mm and less than 30% of fines <6.5mm. Percent of fine material <0.85mm in the channel are known to impact salmonids during the incubation stage where the interstitial spaces between the particles in the redds are filled and dissolved oxygen, needed by the growing embryos, is blocked. Reduced oxygen permeability by intrusive fine particles result in a reduction in the rate of embryo survival. The target of <14% fines <0.85mm is generally supported by literature sources as a level that is reasonably protective, recognizing the fact that spatial and temporal variability does exist around that value. The 6.5mm fraction being impaired has been known to affect salmonid fry emergence. Smaller particles can smother salmonid embryos, especially those 6.5mm and less in diameter (Bjornn, et al 1976). The target of <30% fines <6.5mm is generally supported by literature sources as acceptable for survival to emergence rates and the levels of fines found in unlogged watersheds, recognizing the fact that spatial and temporal variability does exist around that value.

According to RNSP staff, the percentage of fine sediments tends to be higher in the lower watershed (EPA 1998). Upon examination of in-channel sediment data, though the available data is scattered and scarce, compared to TMDL targets for fine materials, significant portions of the basin are impacted by fine sediment. It appears that fine sediment is moving through the system in waves, but that the system overall is still overloaded with small material.

The RNSP and USGS took 145 core samples from the mainstem at five locations and at eight tributaries between 1975 and 1995. Existing data for fines in the <0.85 fraction meet TMDL targets, but fines <6.5mm often exceeded the target of <30%. Small particle sizes may not be desirable for anadromous salmonids, however there is survival of salmonid embryos to emergence and evidenced by the existence of these fish in the watershed. The small particle sizes are more mobile and the opportunity for redd destruction is real in the Redwood Creek watershed. Both may contribute to decreasing populations in conjunction with other limiting factors. Currently, research is taking place to determine effects of turbidity and suspended sediment on salmonid growth and survival that will be useful in future assessments of sediment impairment and sediment sources. This assessment did not evaluate the status of suspended sediments and turbidity regimes in the watershed, therefore, we can not assess the impacts, if any, of suspended sediment and turbidity on salmonid species. We recommend that turbidity and suspended sediment rating curves be developed so as to enable a more accurate assessment of water quality and salmonid health in the Redwood Creek Basin.

Stream Flow and Diversions

[This section should come from the DWR report or should be deleted from the Water Quality section].

Biological

Limited macroinvertebrates or algae sampling have been conducted in Redwood Creek. In 1974 Averett and Iwatsubo (1974) did a study of aquatic life present in Redwood Creek. Sites were selected throughout the watershed, focusing on parklands, and sampled for bacteria, algae and macroinvertebrates. Averett and Iwatsubo concluded that there is an abundance of fine particulate organic mater in the watershed.

Prairie Creek was sampled for macroinvertebrates during the construction of the Highway 101 bypass to determine impacts of fine sediment to macroinvertebrates, and likewise to salmonid populations, in the subwatershed.

Future studies will be an important addition to assess the health and function of the Redwood Creek basin.

Stream Buffer Vegetation

Stream buffers are important to the protection of fish habitat for several reasons. With respect to stream temperature, dense trees immediately along a stream provide shade from direct sunshine on the stream surface. Stream buffers with dense canopy also help to reduce air temperature, thus reducing convective heat inputs to streams; however, scientific investigations are still uncertain as to how wide and dense buffers need to be to adequately provide for this microclimate effect.

Stream buffer analysis was conducted to assess the amount of vegetation cover found along the watercourses within Redwood Creek. The data used for this analysis were the vegetation data, discussed above, plus a 1:24,000 stream coverage developed by CDF from the USGS digital line graphs. The predominant vegetation types found along the watercourses are shown in Figure 12 classed with tree canopy closure. The total buffer of 100 feet on each side of the watercourses covers approximately 5,340 acres. The 100 foot buffer was utilized so that information and parameters would closely follow stream course buffers which would follow those of the Forest Practice Rules. This method should resemble the ground conditions following timber harvest with an approved timber harvest plan under the Forest Practice Act.

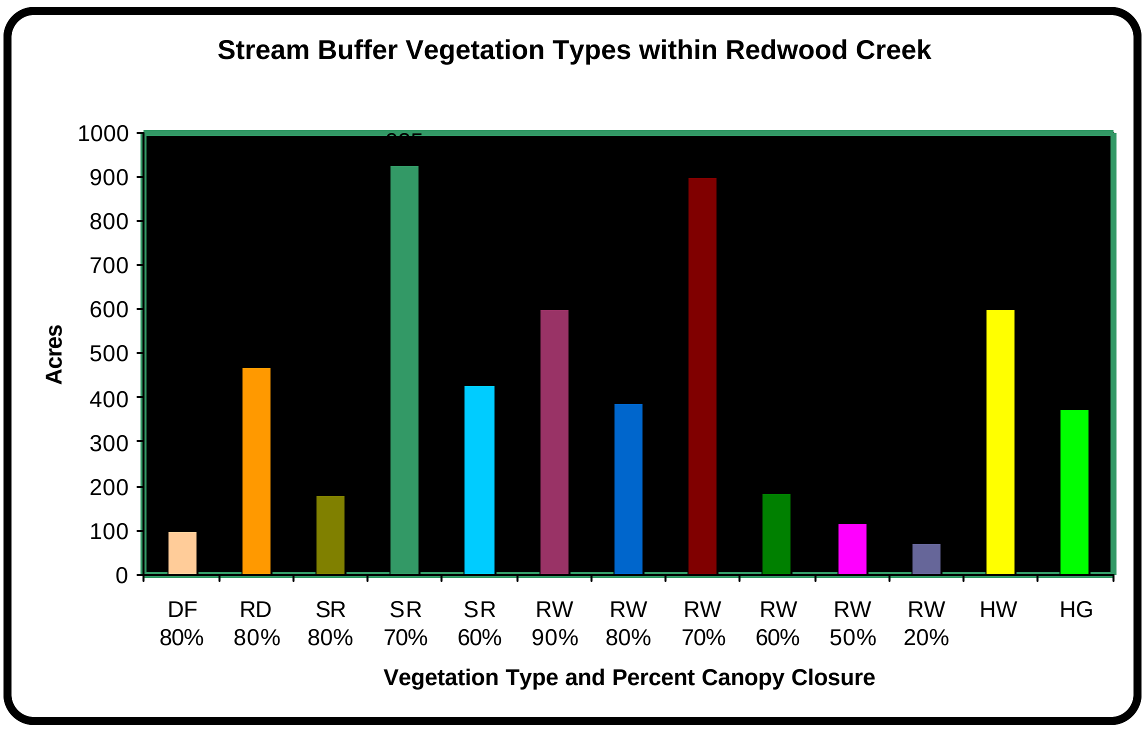

Figure 12: Stream Buffer Vegetation Type and Density Cover.

Vegetation type classes are shown as vegetation type and canopy closure is shown as percent. Douglas-fir (DF), Redwood – Douglas-fir (RD), Sitka Spruce – Redwood (SR), Redwood (RW), All hardwood species (HW) and annual grassland (HG) have no cover percent.

Annual grassland covers 376 acres and is found mainly along the upper reaches if small drainages and watercourses with a southern exposure and would not provide any shading of streams. Conifer classes within the higher crown cover percentage classes provide the largest amount of cover along the streams. Conifers with canopy closure of 70 percent or greater occupy approximately 48 percent of the buffer area. Hardwoods cover 600 acres of the zone. Because of the eight separate hardwood species included in the vegetation information, canopy density was not calculated. Conifers occupy the lower portions of the basin, generally below Lacks Creek they start to become a more significant component of the stream riparian area vegetation.

Stream Reach Assessment

Additional vegetation assessment was completed for the stream reach information collected by the Department of fish and Game. Digital vegetation information was utilized to determine the area and vegetation type, size class and canopy density for the 66 separate stream reaches. A buffer zone of 150 feet along each side of the stream reach was developed to determine specific vegetation information. The 150 foot buffer zone was used because it corresponds to the required watercourse and lake protection zones (WLPZ) outlined in the current Forest Practice Rules. This buffer width would closely resemble the buffer width required for fish bearing streams under the current Forest Practice Rules. The vegetation information was obtained from the CALVEG types. The minimum mapping size is 2.5 acres for contrasting vegetation types. The vegetation layers were then “clipped” to the GIS shape files for the stream reach assessment. Acres of cover type, tree density and percent canopy closure were then calculated utilizing Arc View GIS.

Density Percent	*Acres*
0 - 9%	13.1
10 - 19%	59.2
20 - 29 %	2.5
30 - 39%	4.5
40 - 49%	4.2
50 - 59%	27.5
60 - 69%	23.9
70 - 79%	8.5
80 - 89%	28.5
90 - 100%	5.3

Acres	*Cover Type*
0.4	Ag.
1.1	Barren
52.1	Conifer
61.9	Hardwood
1.7	Grass
58.0	Mixed
0.9	Shrub
1.2	Water

Density refers to the percent of crown closure for all trees within a given area. Cover types are derived from the standard Cal-Veg Classification system. Barren areas have less than 10 percent cover of any vegetation.

Size Class Comparison Chart			*Acres*
Size class code	**Conifer (DBH)**	**Hardwood (crown dia)**	
1 Seedlings	1 - 4.9"	Less than 15'	15.8
2 Poles	5 - 11.9"	15 - 30 '	24.7
3 Small Trees	12 - 19.9"	30 - 45 '	99.6
4 Medium Trees	20 - 29.9"	Greater than 45'	28.6
5 Large Trees	30 - 40"		3.1

Size class refers to the diameter (DBH) size range for all of the conifers. Size class for hardwoods refers to average visible crown diameter. Refer to the chart above for a comparison.

Fish History and Status

Redwood Creek basin supports populations of fall run chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), winter and summer runs of steelhead trout (*O. mykiss*), coast cutthroat trout (*O. clarki clarki*), and other valuable fisheries resources (Table 11). Due to a lack of quantitative information, historical population estimates of anadromous salmonids are unknown. However, based on anecdotal information, expert opinion, amount of historical and current suitable habitat, qualitative assessments, and comparisons with other north coast streams, it is highly probable that populations have declined significantly compared to historical numbers. In 1960, the U.S. Fish and Wildlife Service (FWS) estimated 5,000 chinook, 2,000 coho, and 10,000 steelhead were present in the Redwood Creek basin (USFWS 1960). However, the FWS estimates were based on fish numbers from other streams of similar size and characteristics as Redwood Creek. These numbers are also likely below historical levels. In response to declining populations across their southern range, chinook, coho, and steelhead were listed in the late 1990s as “threatened” under the federal endangered species act. Coast Cutthroat is considered California species of special concern by the Department of Fish and Game. These protective measures are intended to help sustain viable populations and aid in the recovery of stocks at risk of extinction and avoid the status of Atlantic salmon presented below.

> “The historic North American range of Atlantic salmon extended from the rivers of Ungava Bay, Canada, to Long Island Sound. As a consequence of industrial and agricultural development, most populations native to New England have been extirpated. Remnant native populations of Atlantic salmon in the United States now persist only in eastern Maine” (NMFS 2000).

There are approximately 58 miles of Redwood mainstem and 50 miles of tributary streams accessible to anadromous salmonids (Brown 1988). Brown (1988) identified forty-six fish bearing tributary streams to Redwood Creek as it flows approximately 60 miles from its headwaters though a narrow, steep valley basin before entering the ocean near the town of Orick. The steep channel gradient of the tributaries limits anadromous fish habitat to only the lower segments of the tributary streams. Seventy-five percent of the tributary streams provide less than half a mile of anadromous fish (Brown 1988). Prairie Creek is the largest tributary to Redwood Creek. Prairie Creek joins the main channel of Redwood Creek approximately 3.5 miles upstream from the estuary and drains the northwestern, lower gradient portion of the Redwood basin. Prairie Creek contains at least nine fish bearing tributary streams.

Historically, the salmon, steelhead, and cutthroat trout of Redwood Creek were important food supply to Native Americans and are still part of traditional culture. Beginning in the late 1800s, the fish provided sport fishing opportunities and food for early settlers and visitors to Humboldt County. During the early 1900s, commercial gillnetters operating in the tidal area shipped their catches to canneries at Eureka and Klamath (FWS 1960). The salmonid fishery contributed significant revenues to the economy of Orick throughout the 1900s (Van Kirk 1994). Today, the salmon and steelhead of Redwood Creek are managed as “catch and release” only, which likely reduces the numbers of fishers and contributions to the local economy. The presence and health of salmonid populations are also considered by many people to have important esthetic values. Valuable historical information of the Redwood Creek fisheries were published in the Arcata Union Newspaper which are presented along with interviews of long term residents and other anecdotal accounts in Van Kirk (1994).

Table 11: Fishery Resources of Redwood Creek.

Common Name	Scientific Name
Anadromous	
coho salmon	*Oncorhynchus kisutch*
chinook salmon	*Oncorhynchus tshawytscha*
steelhead trout	*Oncorhynchus mykiss*
summer steelhead trout	*Oncorhynchus mykiss irideus*
coastal cutthroat trout	*Oncorhynchus clarki clarki*
eulachon	*Thaleichthys pacificus*
Pacific lamprey	*Lampetra tridentata*
Freshwater	
rainbow trout	*Oncorhynchus mykissirideus*
coastal cutthroat trout	*Oncorhynchus clarki clarki*
coastrange sculpin	*Cottus aluticus*
humboldt sucker	*Catastomus occidentalis umboldtianus*
prickly sculpin	*Cottus asper*
Pacific brook lamprey	*Lampetra pacifica*
threespine stickleback	*Gasterosteus aculeatus*
Marine or Estuarine Dependent	
tidewater golby	*Eucyclogobius newberryi*
surf smelt	*Hypomesus pretiosus*
night smelt	*Spirnchus starksi*
shiner surfperch	*Cymatogaster aggregate*
staghorn sculpin	*Leptocottus armatus*
starry flounder	*Platicthys stellatus*
Amphibians	
Pacific giant salamander	*Dicamptodon tenebrosus*
tailed frog	*Ascaphus truei*
red-legged frog	*Rana aurora*
foothill yellow-legged frog	*Rana boylei*

The first steps towards initiating fisheries management include understanding the life history and habitat requirements of the species, assessing the current conditions in the watershed, and identifying and weighing factors that may limit fish production. The next step is to address the factors or issues that may impair fish populations from reaching their desired status (Leopold 1933).

Chinook, coho, steelhead, and coastal cutthrout utilize an anadromous life history strategy. The term anadromous refers fish that spawn in freshwater and migrate to the ocean to grow and mature before returning to freshwater streams to spawn. Anadromous salmonids utilize diverse interspecific and intraspecific life history strategies in order to reduce competition between species and also to increases the odds for survival of species encountering a wide range of environmental conditions in both the freshwater and marine environments. A summary of the life history strategies, and historic and current status the anadromous salmonid population of Redwood Creek is provided below. Further details are provided in each subbasin discussion. A detailed account of chinook salmon, coho salmon, steelhead and cutthroat trout life histories is presented in Appendix X.

Steelhead

Steelhead trout are an anadromous strain of rainbow trout that migrate to sea and return to inland rivers as adults to spawn. In contrast to all Pacific salmon, not all steelhead die after spawning. U.S Fish and Wildlife service stated that a run of approximately 10,000 Steelhead occurred in Redwood Creek in 1960 (USFW 1960). This is an uncertain estimate, for it was contrived from data relating to other streams of similar size and characteristics which were then applied to Redwood Creek. Redwood Creek supports three different stocks of steelhead: winter run, summer steelhead, and "half-pounders". The latter two are described in the Summer Steelhead portion of the report.

Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least (the most successful young steelhead spend from) two years in fresh water before emigrating downstream. In Redwood Creek, steelhead generally migrate as 2-year old smolts during spring and early summer months. Emigration appears to be more closely associated with size than age, 6-8 inches being the size of most downstream migrants. Downstream migration in unregulated streams has been correlated with spring freshets.

In the Redwood Creek watershed, steelhead were overwhelming the most widespread and numerous species of salmonids observed in 2001 electrofishing surveys. Fifty-four out of fifty seven streams surveyed in the watershed contained steelhead populations of various concentrations (Brown 1988; DFG surveys 2001). Skunk Cabbage Creek was the only stream that is accessible to anadromous salmonids where steelhead have not been observed. This stream supports only coast cutthroat trout (Brown 1988 and DFG surveys). Young of the year steelhead were the dominant age class found. There were a number of streams (Panther Creek, Garrett Creek, Mill Creek, Molasses Creek, Minon Creek, and Lostman Creek) in which the percentage of 1+ steelhead was <25% of the total steelhead count (DFG surveys 2001). The rest of the streams produced lower figures.

Although steelhead numbers have certainly decreased from historic figures, their decline has not been as dramatic as other species of salmonids in the Redwood Creek watershed. This could be attributed to their ability to inhabit stream conditions that are available in many of the tributaries of Redwood Creek. These tributaries have steep gradients, migration barriers, lack of channel complexity, and exhibit higher water temperatures that limit production of other salmonid species. Steelhead have displayed more adaptability to these conditions.

Summer Steelhead

The summer steelhead is an anadromous rainbow trout which migrates to freshwater streams April through July. Summer steelhead enter fresh water sexually immature and consequently must spend several months in Redwood Creek before they are ready to spawn. They rely on the remaining high spring flows to ascend tributaries and smaller streams where they hold in deep pools over the summer and fall. In addition to the depth of pools (>3ft) summer steelhead prefer cool pool water temperatures (mean bottom temperature <19°C, (Baigun et al. 2000) and ample cover such as large rootwads, underwater ledges, caverns, and bubble curtains, which fish seek when disturbed. Generally, summer steelhead spawn from December through February in smaller tributaries or the in headwaters of larger systems, farther upstream than winter run steelhead.

Summer Steelhead are found in a minimum number of streams in northwest California and southern Oregon. Currently, only 20 streams in northern California are populated with summer steelhead. Little is known about historical abundances of summer steelhead due to the lack of quantitative records which date back only the past two or three decades (Roelofs 1983). Native Americans depended on summer steelhead of Redwood Creek for subsistence, and they were frequently harvested in the fall, supplementing the harvest of big game. Sport fisherman used to enjoy the abundance of Redwood Creek summer steelhead runs in the late 1800s to early 1900s. Interviews with long-time residents of Redwood Creek have given testimony to "real good" summer steelhead runs. "There are still a few, but not nearly as many as there used to be" (Van Kirk 1994). Another anecdote from a 1920 article in American Angler gave the following description of summer steelhead in upper Redwood

Creek: “Every pool has ten to twenty five, and they run from twenty to thirty-six inches. Some of the pools were up to 20 feet deep.” (Gerstrung; personal communication).

Today, Redwood Creek supports a very small population of summer steelhead (approximately 30-60 fish). Numbers ranged from a high of 74 adults in 1997 to a low of 3 adults in 2000 (Anderson 1999 and Moyle et al. 1995). These numbers reflects those seen during summer dives from 1981 to 2000, but not all portions of Redwood Creek have been equally surveyed each year, which may contribute to the variability in these numbers.

The low number of summer steelhead presents an alarming problem for long-term survival of this stock. Because the actual number of spawning fish is probably below the number of fish seen, the “effective” breeding population sizes (sensu Meffe 1986) may be less than the minimum size need to sustain a population of summer steelhead. These low numbers combined with poor habitat conditions such as lack of deep pools and high water temperatures are continued threats to the viability to the summer steelhead population of Redwood Creek. Peak mainstem temperatures ranged from 20-27C from 1994-98, (Ozaki et al 1999), lack of large woody debris (LWD/cover), and predation (river otters) on mainstem Redwood Creek underscores the need for proper monitoring and watershed management for this rare and unique race of fish.

The 1964 flood had a large adverse impact on this population. Large amounts of sediments were deposited in the stream channel which filled pools and buried cover elements required to sustain summer steelhead over the summer and fall months. Portions of middle and upper mainstem Redwood Creek appear to be slowly recovering, and there has been an increase in the number of summer steelhead, possibly reflecting these improved conditions. The majority of the stock seems to reside in these mid to upper portions (above Lacks Creek). Lower Redwood Creek, on the other hand, has decreased numbers of Summer Steelhead since 1985.

Coastal Cutthroat

Under development

Chinook salmon

A fall run of Chinook is present in Redwood Creek. Chinook salmon, also referred to as “kings” are the largest of the salmonid species. Chinook typically enter the system in November through January, migrating up to spawning grounds. December marks the height of the spawning period (U.S. Fish and Wildlife, 1960). Approximately 69 miles of suitable Chinook habitat exist within the Redwood Creek basin with 48 miles being in the mainstem (FWS 1960, CDF&G 1965, and Brown 1988). The best historical spawning areas were identified as being in Prairie Creek, the middle reach of Redwood Creek including Minor, and the upper reach of Redwood Creek (FWS 1960). Chinook have also been found in both Bridge and Tom McDonald Creeks in the lower portions of the watershed.

U.S Fish and Wildlife service stated that a run of approximately 5,000 chinook occurred in Redwood Creek in 1960. This is an uncertain estimate, for it was contrived from data relating to other streams of similar size and characteristics, which were then applied to Redwood Creek. This number was significantly higher than a 1979 estimate of 1,850 adults during the fall run (Ridenhour et al. 1994). This estimate was based on the number of juveniles estimated to be in the estuary in early July 1980 (Larson et al 1981). Through the use of a rotary screw trap, which sampled approximately 37 stream miles of accessible salmon and steelhead habitat in the upper 1/3 of the Redwood Creek watershed, a population estimate of 378,000 juvenile Chinook salmon was derived from the capture of 120,692 migrating juveniles. An additional 21 yearling Chinook were also captured (Sparkman, 2001). The possible recovery of the middle to upper portions of the watershed may reflect this population estimate.

Estuaries are considered critical habitat for chinook salmon because they are known to utilize estuaries as part of their life history strategy. The present condition of the Redwood Creek estuary/lagoon has limited the biologic function and therefore production of chinook salmon of Redwood Creek. Over the past 100 years, the physical structure of the estuary has been modified by levee construction, removal of riparian forests, conversion of wetlands to pasture lands, and artificial breaching. These modifications combined with excessive sediment accumulations have reduced the size of the estuary and wetland areas, reduced the tidal prism, and altered drainage patterns all which impair the physical function and the ability of the estuary/lagoon to fully support salmonids. This in turn, had decreased important rearing and holding habitat for juvenile and adult Chinook salmon.

Coho Salmon

California coho salmon (*Oncorhynchus kisutch),* also known as silver salmon, are listed as threatened under the Federal Endangered Species Act (ESA; NMFS 1995). This listing has come as a response to the declining numbers throughout their southern range. A 1995 estimate stated that less than 5,000 wild coho salmon (no hatchery influence) spawned in California each year (Moyle et. al 1995). This is a drastic decline from statewide estimates in the 1940s, which assumed there was anywhere from 200,000 to one million adult coho in California (Calif. Advisory Committee on Salmon and Steelhead Trout 1988). Essentially, coho populations are less than 6% of what they were in the 1940s.

Coho salmon exhibit a three-year life cycle and do not appear to have the genetically distinct and spatially separated runs that chinook salmon and steelhead trout have displayed. After spending two years in the ocean, coho return to spawn in late fall and early winter following seasonally significant rains. As with other species of salmon, coho die after spawning. Unlike other salmon species, coho salmon redds can be situated in substrates composed up to 10% fines (Emmett, et al, 1991), but typically spawning success and fry survival are favored by very clean gravel consisting of less then 5% fines (CDFG 1991).

Juvenile coho typically spend one year in the freshwater streams before migrating out to the ocean (a small proportion of the coho population of Redwood Creek spend two years rearing before migrating to sea). Consequently, adequate cover, cool water, high canopy density, and sufficient food to sustain them through their fry and juvenile stages become critical habitat components. Specifically, secondary channel habitats, such as cool, backwater pools with a large woody debris cover, are highly preferred habitat conditions for developing juvenile coho salmonids (CDFG 1991).

The Redwood Creek watershed, like other systems in California, has suffered declines in populations of coho. Coho were estimated to have a run of 2,000 spawners in 1960 (U.S. Fish and Wildlife 1960). Current, population estimates are not available due to lack quantitative population estimates. It is known that a majority of the coho spawners use the Prairie Creek drainage, which was supplied by the Prairie Creek hatchery until 1992. So while the overall population totals may have remained fair for some time, the percentage of wild stock is assumed to have greatly decreased (D. Anderson, App.; S. Sanders, App.).

Outside of the Prairie Creek drainage, coho have populated portions of the mainstem and eight other tributaries to Redwood Creek. These include: Tom McDonald Creek, Bridge Creek, Harry Weir Creek, McArthur Creek, Coyote Creek, Karen, Strawberry, and Pilchuck Creek (Brown 1988, Neillands, 1990, DFG 2001 surveys). However, electro-fishing conducted in the summer of 2001 did not produce any coho in Bridge, Coyote, Karen, and Pilchuck Creeks, nor in any other tributaries in the middle or upper portions of the basin that were sampled (see Appendix). In addition, through the use of a rotary screw trap, which sampled approximately 37 stream miles of accessible salmon and steelhead habitat in the upper 1/3 of the Redwood Creek watershed in the summer of 2000, no coho were captured (Sparkman 2000).

The construction of the Highway 101 by-pass created a large sedimentation event in 1989 that impacted coho spawning and rearing habitat in the Prairie Creek watershed from Brown Creek to the confluence with Redwood Creek. A 1997 population estimate of 24,588 migrating juvenile coho was made for the portion of the watershed above Streelow Creek (Klatte and Roelofs 1997).

Issues Affecting Fishery Resources of the Redwood Creek Basin

Issues affecting salmonids of Redwood Creek are similar to other North Coast streams. Generally, salmonid populations declined in concert with increased demand for water, fisheries, forest resources, and alterations of land and waterways to meet the demands of increasing human populations. A goal of the NCWAP is to identify and address factors that will help in the management and recovery of these valuable fishery resources.

The primary issues affecting salmonid populations of Redwood Creek are centered around land use activities that contribute to increasing sediment delivery to streams and decrease desirable functions of riparian vegetation. Naturally occurring events such as slope failures, floods, and drought are beyond our abilities to control. However, we can conduct our activities on the lands and waterways of Redwood Creek with oversight to reduce future adverse impacts to stream habitat conditions. Primary issues affecting Redwood Creek are:

- Recent flood events have played an important role in shaping the stream channel and aquatic habitat conditions of the Redwood Creek basin. The flood of 1964 likely has had the most significant and long-lasting adverse impacts to salmonid habitat in Redwood Creek and the entire north coast region. In the upper reach, channel widths increased by 150 to 300 percent and as much as 30 feet of channel fill were deposited above the 1994 thalweg elevation (Madej and Ozaki 1996). Although the upper reach has shown recovery, long-term channel surveys show sediment delivered to the stream system from landslides, debris slides, fluvial hill slope erosion, and road-related problems during the 1964 flood are still stored in the middle and lower reaches of Redwood Creek (Ozaki and Jones 1998 and 1999). Much of these stored sediments were transported from the upper reach and deposited in the lower reach and estuary. Approximately half of the sediment generated from 1954 to 1997 was associated with roads and skid trails and roughly 10-20% was associated with lands managed for timber harvests (USEPA 1998).

- Several factors that limit anadromous salmonid production or impair steam habitat conditions are related to excessive amounts of stored sediments. These include reducing the number, depth, and quality of pools, reducing surface flows, widening the stream channel which can spread a thin flow across the channel which also leads to increasing exposure to solar radiation and air temperature, resulting in elevated water temperature.

- The lack of high quality pool habitat was the most common factor (identified from the EMDS stream reach model results) affecting anadromous salmonid habitat in Redwood Creek basin streams. High quality pools provide sufficient depth and shelter elements for protection from predators, provide cover from high flows, and reduce density related competition. Deep pools may also provide thermal refugia in reaches where water temperature is unsuitable for maintaining healthy salmonid populations. The lack of pools observed in portions of the basin is in part due to the low gradient reaches that are still storing sediment delivered from 1964 flood.

- Intense winter rains and rain on snow events on unstable slopes can often initiate landslides, debris flows, watercourse crossing failures, and fluvial hill slope erosion. Roads built on marginally stable ground are more likely to fail during stressing storms. These processes can deliver large quantities of sediment directly to the stream system.

The following list presents factors that may affect stream habitat conditions and production of anadromous salmonids:

Climate Factors
Precipitation patterns
Floods
Droughts
Rain on snow

Land Use Factors
High road density
Road location/construction
Timber harvest activities
Livestock grazing
Agriculture
Recreation
Restoration

Geologic Factors
Landslides
Earthflows
Highly erodible soils
Fluvial hill slope erosion
Debris slides/torrents

Estuary Factors
Aggraded channel
Levee construction & maintenance
Reduced tidal prism
Water temperature

Fishery Factors
Sport and commercial fishing
Impaired salmonid populations
Prairie Creek Hatchery

Stream Habitat Factors
Water Temperature
Stream flow
Food supply
Habitat diversity
Shade canopy
Large woody debris
Widening stream channels
Riparian vegetation community structure
Aggraded channel

Redwood Creek Assessment Process Summary

NCWAP made a commitment from the outset to work with local parties with interest in and information on North Coast watersheds. NCWAP has worked with various parties on the Redwood Creek watershed to learn of concerns about fish and watershed conditions and to collect data and information. Redwood National and State Park (RNSP) and members of the Redwood Creek Landowners Association (particularly Simpson Timber Company and Barnum Timber) were especially helpful. RNSP shared a large volume of data and reports, and also developed land use GIS coverages under contract to CDF. Timberland owners generously shared aerial photos and allowed access to the ground. NCWAP offers its thanks to RNSP and the landowners for their important assistance.

Some of the specific meetings of NCWAP staff with Redwood Creek parties include the following:

- 3-12-01
  Meeting with NCWAP staff, Redwood National and State Parks staff and members of the Redwood Creek Landowners Association to discuss NCWAP and the Redwood Creek 2001 assessment.

- 4-10-01
  Meeting with NCWAP staff and Redwood National and State Parks staff at the Orick offices to discuss monitoring programs and data sources.

- 7-12 & 13-01
  Redwood Creek Technical Committee meeting at the Wolf Creek Outdoor School. Hosted by the Redwood National and State Parks and the Redwood Creek Landowners Association. RNSP Watershed Analysis update and workshop where NCWAP members were present to learn about research activities occurring in the basin and make contacts with landowners.

- 10-11-01
  NCWAP held a public meeting at the Blue Lake Grange Hall to present the Redwood Creek 2001 Assessment, hear public comments, and share data and history.

This draft assessment of the Redwood Creek watershed is scheduled to be released to the legislature and the public on February 1, 2002. The draft report will be distributed in printed and electronic format to interested parties. Some time after release of the report, NCWAP will hold a public meeting on the Redwood Creek watershed to receive comments on this draft from interested members of the public. Under contract to CDF, the University of California, Berkeley, will conduct a scientist and peer review of the Redwood Creek assessment. NCWAP plans to complete a final draft or this assessment in May 2002.